CALCULATING YOUR PERSONAL RADIATION EXPOSURE

Directions: Calculate your annual exposure using data in the table of average annual exposures (page 6 of the reading lesson entitled *Ionizing Radiation: Sources and Exposures*) and the information given in the work table below.*

Source of Radiation	Annual Exposure (millirem)

COSMIC RADIATION

Effect of Elevation, in feet (mrem/year):

(Exposures reflect 10% reduction for structural shielding)

0 (sea level)	26	4,000	39
500	27	6,000	52
1,000	28	8,000	74
2,000	31	10,000	107

For your elevation of _____ feet, add _____

GROUND RADIATION (U.S. AVERAGE = 28 MREM/YR)

Average ground radiation for various areas:

Atlantic and Gulf Coastal Plain	16
Colorado Plateau Area	81
Rest of the United States	32

Add the ground radiation exposure for the area in which you live. _____

COSMOGENIC RADIATION: Carbon-14 _____

RADON _____

RADIONUCLIDES IN THE BODY: Air, Water, Food _____

BUILDING MATERIALS

Add 7 mrem/yr *7.0*

* In comparing your exposures with those in the main summary table and the pie chart, remember that the table and pie chart contain or reflect numbers obtained by dividing the collective exposures of some segments of the population by the total population of the United States. Such average numbers do not apply to a single, real individual.

MEDICAL DIAGNOSIS

(Add the appropriate exposure for any of the following that you have received.)

X-Rays _____

chest	6 mrem	pelvis and hips ...	65 mrem	CAT scan ..	110 mrem
extremities .	1 mrem	skull, head, neck	20 mrem	PET scan	2000 mrem

Nuclear Medicine: 430 mrem per treatment (U.S. average) _____

JET PLANE TRAVEL (Add 0.5 mrem per airborne hour) _____

NUCLEAR FUEL CYCLE (Maximum of 0.1 mrem/yr) 0.1

FALLOUT FROM ATMOSPHERIC NUCLEAR WEAPONS TESTING ** 0
(No longer significant)

CONSUMER PRODUCTS

Natural gas heating, cooking: 2 mrem/yr _____

Television viewing: maximum of 1 mrem/yr 1.0

Eyeglasses: 0.4 mrem/yr _____

Gas mantles (camping lanterns): 0.2 mrem/yr _____

Dental ware (crowns, dentures): 0.1 mrem/yr _____

NUCLEAR POWERPLANTS 0.05

TRANSPORTATION OF RADIOACTIVE MATERIALS

Per capita U.S. exposure (1993): less than 0.1 mrem/yr 0.1

RADIOACTIVE WASTE DISPOSAL

Low-level burial waste sites: 1 mrem/yr 1.0

TOTAL _____

What is projected for exposure from a high-level waste repository?

High-level waste repository
Emplacement stage: much less than EPA guideline of 25 mrem/yr
Post-closure: 1 mrem/yr

What is the projected exposure from transporting spent fuel to a repository?

Potential exposure to people living near (100 feet to half a mile) the route of a vehicle traveling at 15 miles per hour (mph) and carrying spent fuel is 0.000001 to 0.001 millirem per shipment.

** Above ground tests of nuclear weapons were conducted prior to 1963. Fallout from these tests is no longer considered significant in figuring exposures to radiation because of dispersion and/or radioactive decay.

PENNIUM-123

The participants will simulate radioactive decay and plot the decay of an isotope of the imaginary element pennium.

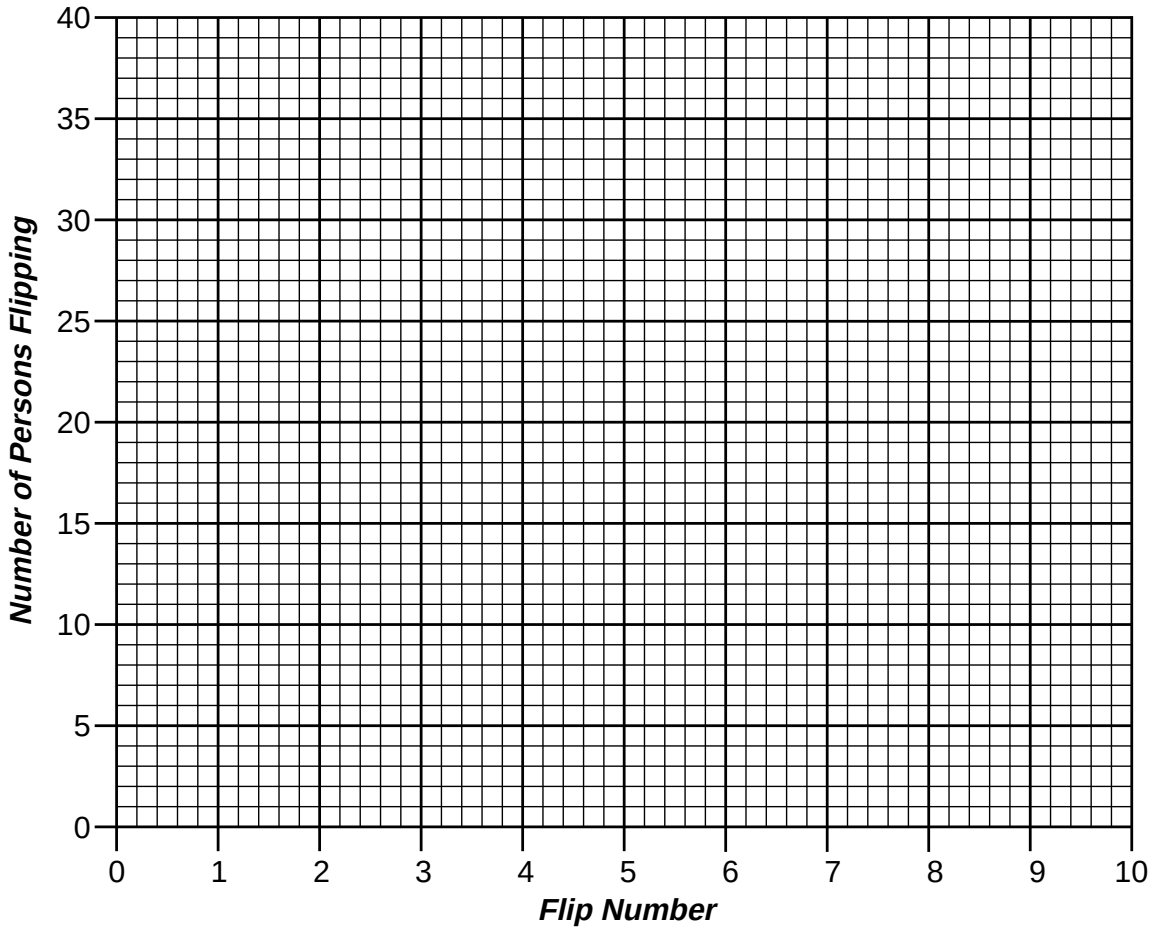
In this activity, everybody has a penny. The discussion leader and participants flip the pennies.

Everyone whose penny matches the leader's flip has "decayed," while those whose penny is different are still "radioactive."

Each time, those who have "decayed" are out.

Count the number out and record the results as indicated on the chart. Then those who are still playing flip again. Continue until everyone is out. Plot the results on the graph below.

Flip Number	Number Decayed	Number Radioactive
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		



Is the number of participants out each turn always one half the number flipped?

_____

Why or why not?_____

_____

_____

HALF-LIVES

The half-lives of some significant radioisotopes are listed below. The radioisotopes listed are fission products, naturally occurring radioisotopes, and transuranics. All are present in spent fuel. Fill in the chart below. (The first problem has been done as an example. y=year; d=day; h=hour.)

Radioisotopes	Type of Decay	Half-Life	How long will it take to lose 1/2 of its radioactivity?	How long will it take to lose 3/4 of its radioactivity?	How long will it take to lose 7/8 of its radioactivity?	Specific Activity (curies/gram)
Fission Products						
Gases						
krypton-85	Beta	10.72 y	10.72 y	21.44 y	32.16 y	392
xenon-133	Beta	5.27 d				186,000
Solids						
strontium-90	Beta	28.1 y				141
molybdenum-99	Beta	66.7 h				474,000
iodine-131	Beta	8.07 d				123,500
cesium-137	Beta	30.2 y				86.4
cerium-144	Beta	285 d				3,182
Natural Elements						
uranium-235	Alpha	710,000,000 y				0.00000241
uranium-238	Alpha	4,500,000,000 y				0.000000334
Transuranics						
plutonium-238	Alpha	86 y				17.47
plutonium-239	Alpha	24,400 y				0.0613
plutonium-240	Alpha	6,580 y				0.226
plutonium-241	Beta	13.2 y				112
americium-241	Alpha	458 y				3.24
americium-243	Alpha	7,370 y				0.200

The higher the specific activity of the radioisotope, the more intense the radioactivity and the more particles or rays emitted in a given time period.

1. Which three radioisotopes have the highest specific activity (curies per gram)?

   _____ _____ _____

2. Which three radioisotopes have the lowest specific activity?

   _____ _____ _____

3. What is generally the relationship between specific activity and half-life? Circle the correct word: The more intense the radioactivity, the (longer? shorter?) the half-life.

In your own words, explain the significance of all of the above information as it relates to permanently disposing of radioactive waste.

_____

_____

_____